Virtual National Laboratory for Heavy Ion Fusion

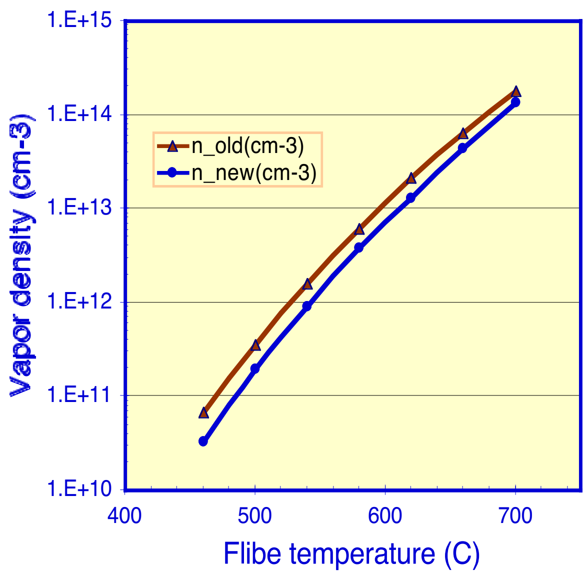
June 2001

HIF News

LBNL-PUB-844-01-06

Flibe vapor pressure 30% lower than previous estimates

The pressure of the vapor species in equilibrium with the molten salt flibe (Li_2BeF_4), in the range of 600°C target chamber operating temperatures, were determined using activity coefficients obtained from three independent measurement methods. This work, performed by doctoral student Grant Fukuda and Prof. Donald Olander, found that the vapor pressure of flibe is approximately 30% lower than values estimated by extrapolation from high-temperature vapor pressure measurements that have been used previously for IFE chamber design, as shown in the figure. The lower vapor pressure will result in heavy ions being stripped to lower charge states than previously thought, and therefore the ions can be more easily focused on the target. The vapor phase is composed of over 90% BeF_2, with the remaining vapor being primarily the mixed dimer $LiBeF_3$. The methods developed in this work also predict the partial pressures of these species. Beam ions will miss the target if they strip within the final focus magnet region. For temperatures near the 460°C melting temperature of flibe, the new results reduce the vapor pressure here, and the consequent beam stripping, by a factor of approximately 50%. Despite this large improvement, even lower flibe temperatures may be required to keep beam loss here sufficiently small. – *Per Peterson and Grant Fukuda*



First beam in Moscow accelerator

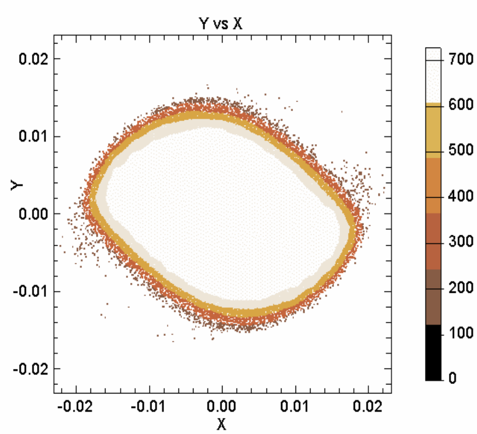
The TeraWatt Accumulator (TWAC) project at Moscow's Institute for Theoretical and Experimental Physics (ITEP) has successfully passed its proof-of-principle test. TWAC is designed for studies in 3 areas: High-energy density in matter, which is related to inertial fusion energy and stellar interiors; relativistic nuclear physics; and cancer therapy using carbon ions. The design parameters are a beam energy of 10^5 Joules, delivered in 20-100 ns, for a power of $\geq 10^{12}$ W (1 Terawatt), and a power density that can be expressed as 120 TW/cm^2, or 10 TW/g.

In the TWAC proof-of-principle test, Carbon 4+ ions from the laser ion source were pre-accelerated in the accelerator/ accumulator facility's new U-3 pre-injector, injected and accelerated in the UK booster ring to 300 MeV per nucleon, stripped to 6+ and stacked into the U-10 storage ring. This marks the completion and commissioning of the new facility's main systems of the new facility's main systems - ion source, ion pre-injector, radio-frequency and power supply for the booster ring, beam transport lines and pulsed magnetic elements. Later this year, the system to extract and transport the beam to the beam-target interaction area will be constructed.

Other upgrades over the next three years will bring the heavy-ion beam to its target values. An emphasis will be placed on developing diagnostics to measure plasma parameters in the unique parameter range of up to T_e ~10 eV, $n_e \sim 10^{23}$ cm^{-3}, and P = 10-100 Mbar. – *Boris Sharkov*

Simulation of aiming and rotation errors in HCX

The HCX experiment will investigate the mechanisms that determine the fraction of the open aperture that can be filled by beam, using a driver-scale beam of ~700 mA at 1.7 Mev. By understanding how to optimize the transport system aperture, we can maximize beam brightness and minimize fusion driver costs. Near the electrostatic quadrupole surfaces, increasingly nonlinear forces may degrade the beam quality and cause particle loss. A single-slice model is used to explore these mechanisms. The transverse space charge forces are treated self-consistently, but the three dimensional external forces are represented by a moment expansion of the fully three-dimensional applied fields, numerically obtained for the electrostatic quadrupole focusing elements.



The simulations exploit the flexibility designed into HCX to study the sensitivity to varying the aiming of the beam from the injector and to rotating the first electrostatic quadrupole. HCX can be operated in a mode where simulations predict a circular cross section beam with no measurable degradation. (All measurements here are at the end of HCX after propagation through the 20 periods of electrostatic quadrupoles.) However, simulating an aiming error of 0.006 radians into the transport system, shows plainly observable effects in slit scan and witness plate measurements of the beam. Similarly, a 4° quadrupole rotation results in the tilted and squared beam cross section shown in the figure. - *Irv Haber*

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This work was performed under the auspices of the U.S. Department of Energy by the University of California Lawrence Livermore National Laboratory under contract No. W-7405-ENG-48 and by Lawrence Berkeley National Laboratory under contract No. DE-AC03-76SF00098 (LBNL), and by Princeton Plasma Physics Laboratory performed under the auspices of the U.S. Department of Energy under contract No.DE-AC02-76CH-O3073.